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Sustainability Ranking for Cuban Tourist Destinations Based on Composite Indexes

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Abstract Tourism sustainability evaluation has become an important issue in the development of this economic industry due to its dependence on natural environment quality and social acceptance. The study shows different ways to measure sustainability by means of composite indicators obtained from an initial set of quantitative and qualitative information. The use of different aggregation methods makes it possible to create rankings and offers remarkable contributions to the decision making process. We use the combination of dissimilar algorithms such as DP_2 distance, Data Envelopment Analysis, Principal Component Analysis and Goal Programming to achieve these rankings and Borda Count to merge them into a single order to compare these destinations. Results shows

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different ways to measure sustainability using the overall information contained in a set of initial indicators and represent an important contribution to composite indicator's building and for the formulation of new strategic actions, politics or other territorial or national projections.

Keywords Tourism sustainability · Composite indicator · DP_2 distance · Data Envelopment Analysis · Borda Count

1 Introduction

Since the end of the last century sustainability has been a key issue in all spheres. It is as important in tourism as in any other sector of the human economy and equally difficult to achieve (Buckley 2012). From a tourist perspective, this concept plays an important role, because this activity is supported by all the available resources present in a destination e.g. natural, cultural, social, economic, political, and technological, among others.

In spite of the limited evidence of its implementation in practice (Sharpley 2009), tourism sustainability has been widely studied in the last decades in the search for a global definition (Waitt et al. 2003), establishing its conceptual dimensions (e.g. World Tourism Organization (WTO) 2004; Choi and Sirakaya 2006; Brun and Hirsch 2008); and defining sustainability indicators; both, single (WTO 2004; Choi and Sirakaya 2006); and composite (Cherchye et al. 2007; Singh et al. 2009; Blancas et al. 2010a, b; Pérez et al. 2013, 2014) supported by the long recognized signification of sustainability indicators in tourism.

For composite indicator studies, a single quantitative measure of sustainability in tourism remains elusive because of difficulties in: definition, what to include, accounting, comparing different impacts in commensurate terms (Buckley 2009) and its multicriterial character due to the wide range of aspects this concept involves. Nevertheless, several methods to create composite indicators have been developed (Nardo et al. 2005; Organization for Economic Co-operation and Development, OECD 2008).

As shown in a variety of studies there are many ways to generate a composite indicator; it is demonstrated that no methodology is more suitable than any other for this purpose (Nardo et al. 2005). There are a variety of methods used in measuring tourism sustainability, such as Data Envelopment Analysis (DEA) (Fuchs et al. 2002), a lineal programming technique that facilitates the estimation of the efficiency of units within production contexts, useful to make relative comparisons. The Analytic Hierarchy Process (AHP) and Fuzzy Set Theory were used in Tsaur and Wang (2007). The AHP was employed to evaluate preference weights of attributes for the stakeholders, because of its capacity to systematize complicated problems, ease of implementation, and integration of the opinions of multiple experts and evaluators. The Fuzzy Theory, a decision-making method, was used to merge the information for its ability to deal with uncertain fuzzy problems (Tsaur et al. 2002).

Moreover, the weighted sum of the sub-indicators can be found, which is the common methodology for its simplicity and the facility to explain the results to the end user. The difference among this method is related to the weighting process, e.g.: multivariate analysis techniques such as confirmatory factor analysis (Kožić and Mikulić 2011; Pulido and Sánchez 2009), the same weight is assigned to every indicator (Castellani and Sala 2010) and some participative process, such as Delphi (Tsaur et al. 2006). Indicators can also be aggregated using an unweighted average, like the tourism penetration index (Padilla and McElroy 2005).

In other fields aside from tourism the use of different aggregation procedures can also be noted e.g.: the use of DEA in the measurement of life quality (Martín and Mendoza 2013) and community well-being (Bernini et al. 2013), multiple-criteria approach to incorporate the opinion of various experts by means of a system of preference aggregation to measure sustainability in Spanish regions (Cabello et al. 2014) and the composite index of sustainable development at the local scale achieved by Salvati and Carlucci (2014) using the Factor Weighting Model (FWM) originally proposed by Salvati and Zitti (2009) and Principal Component Analysis (PCA) (Sharma 2008), among other studies.

The use of different aggregation methods can provoke dissimilar results due to their internal characteristics and the decisions made for their construction. In this sense, the aim of the present study is to create a sustainability ranking for 15 Cuban nature-based tourist destinations, representative of this modality in the country. To ensure the ranking reliability for representing the real sustainability degree, the most sustainable tourism destination serves as a guide and allows the stakeholders to establish the benchmarks for the units with a low sustainability level, we use three specific methodologies developed for this purpose.

The first one, called the DP_2-Distance indicator, was initially developed by Pena (1978) to measure the evolution of social welfare and have some applications in this field (Zarzosa et al. 2005). The method has also been employed to analyze tourism sustainability (Blancas et al. 2007). It is objective and eliminates the problems related to duplicity information as well as avoiding the influence of subjective decisions in which the result may vary depending of the entrance order of the initial indicators.

The second was built by the combination of DEA (Charnes et al. 1978) with the Distance-Principal Component indicator (DPC) (Blancas et al. 2010b) to create the indicator DEA after distance-Principal Component (DEAPC) (Pérez et al. 2013). This index is completely objective and able to identify the strengths and weaknesses of each destination in terms of sustainability.

The third proposed methodology is the DEA after Goal Programming index (DEAGP) (Pérez et al. 2014). It was calculated through the blending of DEA and Goal Programming Synthetic Index (GPSI) (Blancas et al. 2010a), supported in Goal Programming methodology. This method was created with the aim to take into consideration the stakeholders' perspectives with respect to the values of the initial indicators. It is firstly subjective, because the use of goal programming allows the including their aspirations in the dimensional synthetic indicators. The global index becomes objective in the second phase due to the application of DEA.

The last two methods are divided in two stages. In the first one, we calculate a composite indicator for each dimension of the evaluation concept by means of DPC and other using the Goal Programming Synthetic Index (GPSI). In the second stage we use DEA to get a global sustainability index.

DEA has been widely used to build composite indicators (Cherchye et al. 2007; Castellani and Sala 2010) and has three features that make it special for that purpose (Murias et al. 2006). First, benchmarking provides a measure of performance based on real data. Best performance is not a theoretical or abstract concept; it is defined by merely observing the best performer. Second, DEA models possess the immense advantage of displaying unit invariance, which makes the normalization stage redundant. Finally, by allowing every unit to choose its individual weights, DEA respects the individual characteristics of the units and their own particular value systems.

Generally, the use of different procedures can cause dissimilar results and therefore diverse orders when applied to the same group of information. That is why on several occasions it is necessary to look for a method to merge these results and find a general ranking. In that sense, the Borda Count seems to be one of the finest. This method was first taken from the social theory of voting and remains appropriate in order to integrate various rankings (Wu 2011). In data fusion it is a way to amalgamate two or more ranked lists into a single one (Nuray and Can 2006).

Borda Count is a simple summing of expressed voter preferences to achieve a social ranking and can be used as a way to order the alternatives according to their ranking sums (Lamboray 2007). It was proposed by Borda (1784) as a voting method and represents an important step in the development of modern electoral systems (Reilly 2002).

Differing from previous studies, e.g. Pérez et al. (2013, 2014), this research includes the achievement of a sustainability ranking using three different methods and the study of their differences according to the weights and aggregation methods. Additionally, we obtain a meta-index by means of the Borda Count method allowing decision makers to achieve a global ranking representative of the overall sustainability degree for compared destinations. This is a novel approach in the achievement of meta-indexes, allowing us to take into account the strengths of the composite indicators while trying to reduce their weaknesses. It is a new research field in the measurement of sustainability.

Discussion also includes sensitivity analysis to figure out how variations in different indicators affect the rankings of the composite indexes and the global ranking. Finally, this paper is more focused on rankings than on the methodology.

2 Aggregation Procedures

2.1 DP$_2$-Distance Indicator

This index was created by the modification of Ivanovic distance, adding the determinant coefficient to the weighting system (Pena 1978). In effect, the DP$_2$-Distance for a destination is defined as:

$$DP_2 = \sum_{i=1}^{n} \frac{d_i}{\sigma_i}\left(1 - R^2_{i,j-1,i-2,\ldots,1}\right) \text{with}\, R^2_1 = 0$$

For $i = 1,\ldots, n$, d_i is the distance between the observed unit and the reference situation for the ith indicator and σ_i is the standard deviation of the ith indicator. The d_i dividing the standard deviation of each indicator eliminates the problems associated with the measurement units. $R^2_{i,\ i-1,\ldots,1}$ is the determination coefficient and the term $1 - R^2_{i,\ i-1\ldots1}$ is the correction factor that represents the variability percentage of the ith indicator that is not lineally explained for the previous $i - 1$ indicators. In this way, the problem of information duplicity is solved because this coefficient eliminates the information contained in the ith indicator contributed in the $i - 1$ indicators previously added.

Weights represent the amount of new information added for each indicator included in the calculation process. Therefore, this index weights the differences between the indicators and their reference values for the percentage of new information that each indicator added to the global measure provides.

The DP$_2$ value varies when the order of the initial indicators is modified in the calculation because of the determination coefficient. In that sense, it is necessary to establish a hierarchy process to guarantee an order for the initial indicators. Hence, we will use the iterative procedure that begins from Freshet's distance (Pena 1978) applied for Zarzosa et al. (2005) to achieve this goal, based on the rule that the amount of information that each indicator contributes will be bigger while the correlation between the indicator and the DP_2 composite measure is larger. The entry order of each initial indicator to the global measure is conditioned by the amount of information contained in it. In that way, the first added indicator will be the one with more information about the analyzed phenomenon.

This procedure has some advantages such as its calculus objectivity, its independence from normalization processes and that its weights are determined endogenously in such a way that eliminates the duplicity of information since each indicator is weighted by the amount of information that is not included in the previous added indicator. It has no implication with the end user and is easy to understand because it is a simple measure based on the distance to a reference point. As a negative aspect we must point out that the value of the synthetic indicator is affected by the entry order of the initial indicators. In that sense, we propose another aggregation process to look for dissimilarities in the results.

To determine the global DP_2-Distance indicator, the first step is obtaining the dimensional indicators, taking the maximum score for each indicator as the reference value. For the construction of global index, we chose a representative group of initial indicators for each dimension. Initial indicators that show a correlation level >0.5 with the dimensional measures were selected. Weights are represented by the variability percentage of the ith indicator that is not lineally explained for the previous $i - 1$ indicators. This means the amount of new information added for each indicator included in the calculus process.

2.2 Composite Indicator Using Data Envelopment Analysis

2.2.1 First Step: Distance-Principal Component Indicator (DPC)

This indicator combines PCA with the concept of distance to a reference point based on a multicriteria decision-making philosophy and is defined as follow:

$$DCP_i = \sum_{j=1}^{q}\left[VE_j\left(\sum_{k=1}^{p} IN_{ik}\left|Corr_{jk}\right|\right)\right]$$

for $i = 1, 2,\ldots, n$, where n is the number of observations, p is the number of original indicators, q is the number of components selected, VE_j is the variance explained by the jth component, and $Corr_{jk}$ is the correlation between the jth component and the kth indicator. IN_{ik} is the normalized value of the ith observation in the kth indicator, which is needed to normalize the data such that the measuring units used for each indicator have no effect on the final result. This procedure involves dividing the distance to the anti-ideal point by the difference between the maximum and the minimum value:

$$IN_{ik} = \frac{I_{ik} - Min}{Max - Min}$$

where I_{ik} is the value of the ith observation in the kth indicator. We have taken the minimum value of each indicator as the reference point, bearing in mind that higher values indicate that the destination is assumed to be more sustainable. Thus, when measuring the distance to the minimum value, we obtain the distance to an anti-ideal point; when this distance is larger, the destination's sustainability is higher. For the calculation process, the reference value is the minimum of each indicator, under the assumption that higher scores indicate what destinations are more sustainable. This approach has some advantages such as the ease to interpret the final result because the values of the initial indicators are defined according to their distance to a fixed reference value such that the synthetic indicator is a linear combination of these distances and not of the principal components. It is less subjective than other methods because the end-user's task consists only in choosing the initial indicators and the criteria to select the components.

Weights are determined endogenously taking into account data variability, expressed by the product of the explained variance by each chosen principal component and the absolute value of the correlation of each indicator with the chosen principal component. It represents the quantity of information explained by the components and the contribution of each initial indicator to this variance.

2.2.2 First Step: Goal Programming Synthetic Index (GPSI)

The GPSI is found from the procedure of Blancas et al. (2010a), supported in Diaz-Balteiro and Romero (2004) considering a set of m initial indicators (I_j with $j = 1, 2,\ldots, m$), for n units (U_i, with $i = 1, 2,\ldots, n$) where X_{ij} represents the value of the ith unit valued in the jth indicator with $1 \leq i \leq n$ and $1 \leq i \leq m$.

We differentiate between positive and negative indicators, depending on the improvement direction ("more is better" or "less is better"). The indicator is considered positive (I_{ij}^{+}) when a higher value represents an improvement in sustainability in the area. In contrast, the indicator is negative (I_{ik}^{-}) when a higher value represents deterioration in sustainability. The proposed procedure requires us to identify the improvement direction of each indicator, but without the need to convert all of them into the same type, positive or negative. This facilitates the interpretation and management of the results, as no conversion is required.

Then we determine the aspiration levels for each indicator, u_j^{+} for the positive and u_k^{-} for the negative. Later we create the goals introducing the deviation variables to measure the difference between the indicator value and the aspiration level:

For positive indicator: $I_{ij}^{+} + n_{ij}^{+} - p_{ij}^{+} = u_j^{+} \quad \text{with} \quad n_{ij}^{+}, p_{ij}^{+} \geq 0, \quad n_{ij}^{+} \cdot p_{ij}^{+} = 0$

For negative indicator: $I_{ik}^{-} + n_{ik}^{-} - p_{ik}^{-} = u_k^{-} \quad \text{with} \quad n_{ik}^{-}, p_{ik}^{-} \geq 0, \quad n_{ik}^{-} \cdot p_{ik}^{-} = 0$

where n_{ij}^{+} is the undesirable variable for positives indicator and p_{ik}^{-} the undesirable variable for negatives. Higher values of these variables reveal absence of sustainability. This procedure allows obtaining several indexes and we choose the Net Goal Programming Synthetic Index GPSI$^{\mathrm{N}}$, for its compensatory character among the strength and weaknesses for each unit under evaluation. This composite indicator evaluates the relative situation of each unit without demanding the execution of all the aspiration level to determine the sustainability degree for a destination versus their competitors. The GPSI$^{\mathrm{N}}$ for a unit is defined as:

$$GPSI_i^N = \sum_{j \in J} \frac{w_j^{+}\left(p_{ij}^{+} - n_{ij}^{+}\right)}{u_j^{+}} + \sum_{k \in K} \frac{w_k^{-}\left(n_{ik}^{-} - p_{ik}^{-}\right)}{u_k^{-}} \forall i \in \{1, 2, \ldots, n\}$$

w_j^{+} and w_k^{-} are the weights for positive y negative indicators respectively. The first sum exposes the difference between the strengths and weaknesses for positive indicators and similarly the second sum does this for the negative indicators.

The GPSI methodology has several advantages over other methods. It requires no previous normalization method. Second, the methodology can be applied when the number of indicators is greater than the number of units of the initial system, making it useful in practice. Third, this new methodology builds the final synthetic indicator using all the indicators of the initial system and thus there is no loss of information. The results are easy to interpret.

Once we have obtained the dimensional indicators, the second stage involves the use of DEA to generate a global index, as we mentioned before.

2.3 Second Step: DEAPC and DEAGP Global Indicators

For this stage, the initial information was previously obtained by the dimensional indicators for each destination. They are positive and can be employed as outputs to obtain the global synthetic index. We can use a single dummy input with value unity for each destination; the global index value is the virtual output. This model is formally equivalent to the original input-oriented, constant-returns-to-scale DEA model presented (Charnes et al. 1978). In this way, the global synthetic index for the i_0 observation is obtained by solving the following Linear Programming problem:

$$DEA_{i_0} = Max_w \sum_{j=1}^{d} w_j^{i_0} DI_{i_0 j}$$

Subject to

$$\sum_{j=1}^{d} w_j^{i_0} DI_{ij} \leq 1 \forall i = 1, \ldots, n (\text{normalization constraint})$$

$$w_j^{i_0} DI_{ij} \geq \omega \forall i = 1, \ldots, n, \forall j = 1, \ldots, d (\text{virtual output constraint})$$

$$w_j^{i_0} \geq 0 \forall j = 1, \ldots, d (\text{non} - \text{negativity constraint})$$

where $w_j^{i_0}$ are the weights for the observation i_0, DI represents the jth dimension indicator for the ith observation, DPC if the global index refers to DEAPC (Pérez et al. 2013) or the GPSI if the global measurement represents DEAGP (Pérez et al. 2014); d is the number of dimensions considered (in our case, three: social, economic, and patrimonial), and ω is a real number that represents the minimum value allowed for the jth virtual output for the ith observation.

The objective function chooses the weights that maximize the value of the composite index for observation i_0. In the best situation, the global synthetic index takes a value of 1, which implies that the destination has a performance equal to its reference unit. The 0 value represents the worst situation. Thus, the composite indicator takes the form $0 \leq DEA_{i_0} \leq 1$ for each destination, where higher values represent better overall relative sustainability.

This procedure, in general terms, has the advantage of obtaining a composite indicator value sensitive to the stakeholder's needs; more weight is given to those indicators for which some destinations are in a better position compared to others included in the study. In this way, the strengths and weaknesses of destinations can be evaluated. Weights are calculated such that the maximum possible value is determined for the composite indicator in each destination. This indicates the flexibility of the procedure, since the same level of importance does not need to be given to each indicator in the different destinations. In addition, the use of DEA in the second stage indicates how each dimension contributes to the overall value of the DEA index.

As we may note, the three previously explained procedures have differences such as the variability of the results due to the entry order of the initial indicators in the calculation process, the introduction of subjective judgments that permits us to take into consideration the necessities of the stakeholders, and the method used to calculate the weights that represent the importance for each indicator analyzed. All these aspects can cause differences in the results obtained from the application of one or another procedure.

Generally, different methods can cause dissimilar results and therefore diverse orders when they are applied to the same group of information. That is why in several occasions it is necessary to look for a method to merge these results and find a general ranking. To achieve this purpose we propose the Borda Count.

2.4 Borda Count

The Borda Count method uses mapping from a set of individual rankings to create a combined ranking that leads to the most relevant decision (Lumini and Nanni 2006). In Borda Count, a voter ranks all candidates in a strict order by assigning different points according to the rank order (Vainikainen et al. 2008).

This method assigns zero points to a voter's least preferred option, 1 point for the next option, and $(n - 1)$ points for the most preferred (where n is the number of alternatives). However, the way of assigning zero point to the least candidate is unfavorable to implement the analytical calculation (Lawrence et al. 2012). The Borda ranking is then determined by ordering the Borda scores.

It has been used as a data fusion technique for combining ranked lists (e.g. Wu 2011; Ortega et al. 2013) and also in the selection of an icon dish for a local restaurant to promote food tourism by Lawrence et al. (2012) and as a voting technique applied in forest decision making problems in Lakicevic et al. (2014) among others.

3 Empirical Study

3.1 Indicators

Our empirical study took place in Cuba when comparing 15 nature-based tourism destinations (Table 1) representative of the overall offer of this modality in the country. This kind of tourism plays an important role in Cuban tourist development due to the options necessary for increasing tourist offerings with the objective of maintaining a preference position among the competitors in the Caribbean, where sun and beach is the principal attraction.

There is continuing debate on the dimensions of sustainable tourism development. These dimensions have been identified in different ways by several authors (e.g. WTO 2004; Krajnc and Glavic 2005; Choi and Sirakaya 2006; Díaz and Norman 2006; Brun and Hirsch 2008); however, the currently accepted dimensions include all the sectors that operate in any locality and their relationships in different contexts. In that sense, we use those sectors established in the Caribbean Zone of Sustainable Tourism proposed by Díaz and Norman (2006): social, economic and patrimonial.

Table 1 Cuban nature-based tourist destinations

Destinations	
1	Guanahacabibes National Park
2	Viñales National Park
3	San Diego de los Baños
4	Soroa-Las Terrazas
5	Ciénaga de Zapata
6	Hanabanilla
7	Guajimico
8	Topes de Collantes
9	Alturas de Banao
10	Caguanes National Park
11	Mayarí
12	Desembarco del Granma National Park
13	Marea del Portillo
14	Baconao
15	Alejandro de Humboldt National Park

We get a set of 39 indicators representative of the sustainability concept separated in three groups according to the dimensions: 11 social, 14 economic and 14 patrimonial (Table 2). The indicators were selected by their representativeness in different studies (e.g. WTO 2004; Krajnc and Glavic 2005; Choi and Sirakaya 2006; Díaz and Norman 2006; Cracolici and Nijkamp 2008; Blancas et al. 2011). This table also contains the sign, representing the improvement direction for each indicator; this is, "more is better" or "less is better" for positive and negative respectively. Additionally, the minimum and maximum value for each indicator ant their measurement units.

We propose both objective and subjective indicators because indicators based solely on tourist, resident or operator perceptions may be incomplete, since people may not always perceive, understand or care about their impacts (Dodds et al. 2010; Miller et al. 2010).

The introduction of subjective indicators is based on the small leading role given on different sustainability studies to the local population as an important agent in the process of tourism management, as stated in Gursoy et al. (2002) and, moreover, too much importance is given to objective indicators, ignoring the important role that subjective components and perceptions have on the satisfaction of internal (local population) and external customers (tourists). Therefore, from the total number of selected indicators, 16 are subjective and 23 are objective.

Objective indicators are derived from statistical data sources, such as statistical offices, annual reviews of different establishments and entities, data reporting enterprises, and others. On the other hand, subjective indicators concern the perceptions of those involved in tourism development, implying the local residents or the visitors.

Indicators IS_1 and IS_2 are representative of the social benefits associated with tourism, taking into account the improvement in life conditions of a community as a result of tourism. IS_3 and IS_4 indicators were selected to measure the general effects of tourism in the area. In IS_3 the objectives or limits are established concerning the number of tourists that the community can embrace without affecting their optimal benefits. This can be used to obtain objective data to help the decision process about how many tourists are too many or too few.

Table 2 Indicator system to measure sustainability

No	Indicator	Dimension	Sign	Min.	Max.	Units
IS_1	Local population perception if an improvement of highways and transportations infrastructure is because of tourism	Social	Positive	2	4.13	Score
IS_2	Local population perception if an improvement of public services is because of tourism	Social	Positive	2	3.7	Score
IS_3	Proportion of tourist with regard to local population (Month of maximum affluence)	Social	Negative	−0.5574	−0.0034	Ratio
IS_4	Local population perception about if tourist has an undesirable effect in the life style of the destination	Social	Negative	−2.28	−1.65	Score
IS_5	Local population perception if tourism contributes to maintenance of the young population in the municipality	Social	Positive	2.05	3.43	Score
IS_6	Number of local employees in tourism	Social	Positive	31	4278	Units
IS_7	Women's percentage with regard to the employees in tourist sector	Social	Positive	24.24	54.89	Percent
IS_8	Percent of local population who works in tourist sector	Social	Positive	0.13	14.52	Percent
IS_9	Local population perception of the increase of level of life as a tourism consequence	Social	Positive	2.33	4.03	Score
IS_{10}	Tourist valuation about the security in the destination	Social	Positive	3.07	4.27	Score
IS_{11}	Tourist perception about public services quality (illumination, transport, banks services, etc.)	Social	Positive	2	4.06	Score
IE_{12}	Quality-price perception of lodging in the destination (Private and non-private)	Economic	Positive	2.655	3.924	Score
IE_{13}	Quality-price perception of restaurants in the destination	Economic	Positive	2.49	4	Score
IE_{14}	Valuing of the quality of tourist employees (Hotels, Gastronomy and tourist guides)	Economic	Positive	2.98	4.41	Score
IE_{15}	Occupancy ratio for official accommodations	Economic	Positive	5.17	62.87	Percent
IE_{16}	Proportion of tourists in the months of maximum and minimum affluence	Economic	Negative	−12.44	−1.88	Ratio
IE_{17}	Average tourist stay	Economic	Positive	1.21	8.18	Nights
IE_{18}	Percent of seasonal employees in tourism	Economic	Negative	−13.72	0.00	Percent
IE_{19}	Tourist offer	Economic	Positive	0.09	1.51	Partial Index
IE_{20}	Tourist valuation of the accessibility quality and the signalization of the attractiveness	Economic	Positive	2.125	3.36	Score

Table 2 continued

No	Indicator	Dimension	Sign	Min.	Max.	Units
IE_{21}	Number of tourist	Economic	Positive	826	140098	Units
IE_{22}	Tourist incomes	Economic	Positive	375.5	12855.1	CUC (thousands)
IE_{23}	Destination profitability	Economic	Positive	0.25	1.72	Partial Index
IE_{24}	Average tourist-day expenditure	Economic	Positive	37.16	366.64	CUC
IE_{25}	Percent of general economic plan execution according to wished goals	Economic	Positive	51.72	98.95	Percentage
IP_{26}	Energy consumption by tourist and day	Patrimonial	Negative	−47.23	−3.47	CUC
IP_{27}	Energy consumption of renewable sources by year attributable to tourism	Patrimonial	Positive	0.24	133.79	Tonne of oil equivalent (toe)
IP_{28}	Volume of daily water consumption of tourism	Patrimonial	Negative	−299.85	−0.68	m^3
IP_{29}	Percentage of local population with access to clean water	Patrimonial	Positive	38.50	87.50	Percent
IP_{30}	Volume of solid waste attributable to tourism	Patrimonial	Negative	−484.24	−2.07	kg
IP_{31}	Reduction of solid waste attributable to tourism	Patrimonial	Positive	0.0083	0.9600	Percent
IP_{32}	Tourist valuation about the cleanliness in destination	Patrimonial	Positive	3.02	4.40	Score
IP_{33}	Extension of the area dedicated to tourism usage	Patrimonial	Positive	16.24	4260.76	km^2
IP_{34}	Number of tourist per square kilometer	Patrimonial	Negative	−476.12	−2.49	Tourist/km^2
IP_{35}	Use intensity of cultural sites	Patrimonial	Negative	−100.81	−1.13	Ratio
IP_{36}	Tourist valuation of the activities relate to natural resources in the destination	Patrimonial	Positive	3.07	4.45	Score
IP_{37}	Local population perceptions about the environmental and natural damages caused by tourism	Patrimonial	Negative	−1.708	−1.045	Score
IP_{38}	Local population perceptions about the stimulus of craftsmanship and local culture because of tourism	Patrimonial	Positive	1.85	4.36	Score
IP_{39}	Tourist valuation about the conservation of natural resources and heritage in destination	Patrimonial	Positive	2.6	4.24	Score

CCP Cuban Convertible Peso

The IS_4 indicator is used because the daily exchange with tourists and the creation of facilities and activities related to these processes may cause changes in the traditional professions in areas related to tourism, or variations in the life style and different behaviors with respect to the community that can be reason for residents' dissatisfaction.

The IS_5 is justified because migration to places with greater economic opportunities (especially for youth) is a common problem. That is why higher values of this indicator may be associated with greater tourism development and community participation in its benefits.

The following four indicators (IS_6, IS_7, IS_8 and IS_9) represent the economic benefits for the community. In that sense, the IS_6 reflects the ability of tourism to generate jobs in the local area; IS_7 represents the employment opportunity for women and IS_8 concerns the percentage of working age population that is employed in tourism. While using the IS_9 it is possible to evaluate if benefits associated with tourism reflect a direct improvement in the quality of life of the residents.

The IS_{10} was chosen because it is advisable to have a security system and specialized tourist attention, considering that decisions about where to go depend so much on the perception of safety or danger. Meanwhile, the latest indicator of this dimension (IS_{11}) assesses the perceived quality of public services in the community, but this time from the visitors' perspective.

The economic dimension is formed by indicators from IE_{12} to IE_{29}. IE_{12}, IE_{13} and IE_{14}, which are used to obtain information about the tourists' satisfaction level since it determines the likelihood of returning to the destination, recommending it to other people or, in contrast, discouraging others to visit it. As such, these are key indicators for sustainability in a long-term period.

Indicators from IE_{15} to IE_{17} are direct measures of the tourism seasonality degree, as very few destinations enjoy stable tourism throughout the year, which makes it a desired condition. While the IE_{18} is another seasonality measure but referring to tourism employment.

The IE_{19} indicator is representative of the range of services offered in a tourist destination, the quality accommodation and its availability. The IE_{20} evaluates the design of infrastructure and accessibility to the destination and is important because the success of a tourist destination is intrinsically linked to its accessibility.

IE_{21} through IE_{24} measure the general behavior of the tourism industry, which is very important, since the information used in these indicators will be collected during the planning process and may be useful as a reference list for planners. The final indicator of this dimension (IE_{25}) measures the percentage of implementation and compliance with the territorial ordering plan of the municipality.

The third dimension is the patrimonial, with 14 indicators from IP_{26} to IP_{39}. The IP_{26} and IP_{27} measure the energy administration and the use of sources of renewable energy respectively. They are useful to observe the tendencies of energy consumption and allow the destination to supervise yield and measure the variations in the levels of mix and usage.

The IP_{28} comes into the group of those considered necessary for planning tourism zones and IP_{29} measures the evolution of the freshwater supply service in destination areas, although its basic use is to show the safety of the water supply.

The IP_{30} and IP_{31} include all factors related to waste generation, such us the dumping of waste material into a landfill, which represents a waste of resources whose replacement increases the emission of greenhouse gases during production and transportation. The first step is to try to reduce the amount of material used (including packaging) to then consider reusing them and, if it is not possible, recycling. The IP_{32} is included because the abandoned wastes without any control may cause inconvenience to tourists and affect the prestige of the destination.

From IP_{33} to IP_{35} the objective was to measure tourism numbers according to desired use levels and estimate the moment where norms will be met and the established thresholds surpassed. Indicators from IP_{36} to IP_{39} are subjective. The IP_{36} and IP_{37} quantify the environmental impacts of tourism on the community and the IP_{38} and IP_{39} evaluate the local identity and culture.

Besides the dimensions, the initial indicators are classified as positive and negative. Positive indicators are those for which higher values represent a great sustainability level and negatives, those for which lowest levels indicate a good sustainability behavior.

The strength of a composite indicator can largely depend on the availability of good quality underlying data (Nardo et al. 2005). In order to guarantee the quality of a database for the present study, it is necessary to determine its availability to measure the phenomenon under evaluation. We use the Cronbach's alpha as a representative measurement of the internal consistency of the database. A coefficient value of 0.7 is acceptable; some authors suggest 0.75 or 0.80 and others consider more than 0.6 to be a good rate (OECD 2008). C-alpha was 0.7759 for the indicators selected in our study and are therefore representative of sustainability.

4 Results and Discussion

Results are presented in Table 3, where the rankings for each methodology and the overall sustainability ranking appear. As pointed out before, differences among the procedures may lead to alterations in the rankings, caused by the weighting and aggregation process. In this sense, weights are achieved in a different way for each methodology. That is the reason for the existence of dissimilarities among the importance of the dimensions for the indexes.

Table 3 Rankings obtained from the tree methods and the Borda Count

Destination	DP_2 ranking	DEAPC ranking	DEAGP ranking	Borda count
Guanahacabibes N. P.	1	4	5	3
Viñales N. P.	12	14	14	14
San Diego de los Baños	11	13	8	11
Soroa-Las Terrazas	14	12	12	12
Ciénaga de Zapata	2	5	2	2
Hanabanilla	7	9	9	8
Guajimico	15	15	11	15
Topes de Collantes	13	10	15	13
Alturas de Banao	10	11	6	9
Caguanes N. P.	3	6	10	7
Mayarí	5	3	4	4
Desembarco del Granma N. P.	4	7	7	6
Marea del Portillo	9	8	13	10
Baconao	6	1	1	1
Alejandro de Humboldt N. P.	8	2	3	5

4.1 Composite Indicators' Results

Figure 1 demonstrates the importance level for each dimension with respect to the mean of the dimensional weights of all the indicators taken into account for the calculation process. It can be seen that the most importance was attained by the social dimension with the DP_2 methodology. In second place appeared the patrimonial, and the economic was third. For DEPC and DEAGP indexes, the importance order was patrimonial, economic and social. The high value of the weights for the patrimonial dimension of the DEAGP index could be attributed to the lower values of the patrimonial indicators that were used as outputs in this method. Thus, due to these lower values, when using DEA those destinations that opted for the patrimonial dimension in the comparison gave higher weights to the patrimonial dimensional indicators to maximize the value of the composite index for the observations.

For the DP_2 index, indicators included in the measurement were those with a correlation level >0.5 with the dimensional indicators. In this sense, the analysis for this ranking has to be made starting from the information of 16 initial indicators: four social, six economic and six patrimonial: IS_1, IS_7, IS_{10}, IS_{11}, IE_{12}, IE_{13}, IE_{14}, IE_{19}, IE_{20}, IE_{22}, IP_{27}, IP_{28}, IP_{30}, IP_{34}, IP_{35} and IP_{39}.

Taking the first three destinations as reference and according to the DP_2 composite indicator, the best are Guanahacabibes National Park, Ciénaga de Zapata and Caguanes National Park. These destinations perform well in the percentage of women with respect to the employees in the tourist sector, with 49.78 %. These are the destinations with higher values of perceived security and good perception of public services quality from the point of view of the visitor. For the last two indicators, Guanahacabibes National Park and Ciénaga de Zapata have achieved the best scores.

From an economic perspective, these destinations have good scores in terms of quality-price of lodging, restaurants and a good evaluation for the employees, where Guanahacabibes N. P. is the best destination. Furthermore, Ciénaga de Zapata is the second destination with higher tourist incomes. Concerning the patrimonial dimension, these destinations have good values for use intensity of the cultural sites and also the better conserved natural resources and heritage.

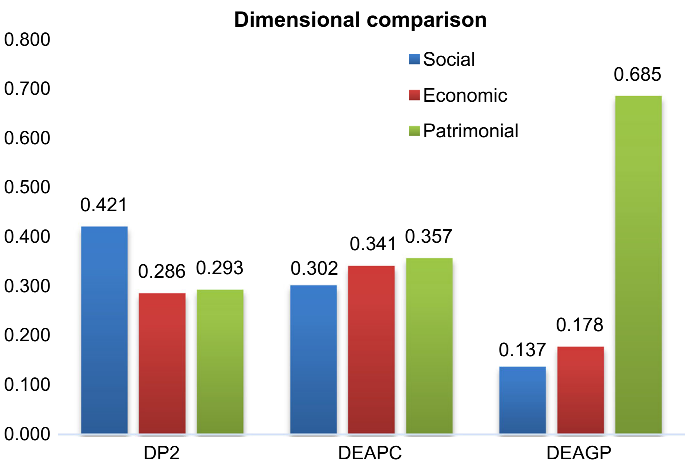

Fig. 1 Dimensional comparison according to the importance level

The DEAPC indicator ranks Baconao, Alejandro de Humboldt National Park and Mayarí as the most sustainable destinations. Results for this index depend on the combinations of the weights and the dimensional indicators. Baconao has a good result in the three dimensions, while Mayarí performs well in social and patrimonial issues and Alejandro de Humboldt N. P. mainly in economic aspects.

A detailed analysis allows us to observe how the three best destinations are those where social benefits have improved due to tourism, mainly those related to highways and the transportation infrastructure. They are also the destinations less affected negatively by tourism because of the low ratio of tourists to local population during the month of maximum affluence and have a high number of local employees in tourism, with an average of 1794 approximately. Regarding this dimension, residents believe that the quality of life has increased as a consequence of tourism development.

In the economic dimension, the best destinations have a 51.4 % occupation rate for the official accommodation and an average stay of 4.81 nights, which is more than two nights above the mean for this tourist modality in Cuba. Also, tourists have a good perception about the accessibility to these destinations.

In the patrimonial dimension, the best destinations have a higher percentage of individuals with access to clean water (76.95 %). They have low intensity of use of cultural sites with approximately 12 tourists per day visiting monuments and a good perception about the activities related to natural resources in the destination.

Results for the DEAGP index coincide within the three most sustainable destinations with the previous composite indicators. Baconao and Alejandro de Humboldt National Park have the same rank in the DEAPC and Ciénaga de Zapata again appears within the best destinations also in the DP_2. In this sense, the analysis is very similar to the already done.

Considering DEAGP index, the most sustainable destinations are Baconao, Ciénaga de Zapata and Alejandro de Humboldt N. P. From the social point of view, these destinations have better social benefits because of tourism, with a good perception of the improvement of transportation infrastructure and public services at the local level. A high number of employees in the sector (approximately 1780) and the individuals believe that tourism has increased the quality of life for the host communities.

Regarding economic issues, these destinations achieved a good occupancy ratio for lodging, with values over the 52 % and a wide tourist offer. They are also the destinations with the best overall performance of the tourist industry, the greatest number of visitors (an average of 25,026 approximately) and those that generate high tourist incomes of almost 14.2 million dollars per year.

In sum, it can be noted how Baconao, Ciénaga de Zapata and Alejandro de Humboldt National Park, appear twice in one of the first three positions for the rankings. Thus, for the global order, Baconao and Ciénaga de Zapata are the first and second destinations in terms of sustainability in Cuba, while Alejandro de Humboldt National Park occupies the fifth position. This is because it is the destination with the higher variation registered, 8th with DP_2 results, 2nd and 3rd with DEAPC and DEAGP respectively. Among the rankings there is an approximate average variation between 1 and 5 units.

It is easy to appreciate the differences among the obtained rankings. Despite the observed variations, the Spearman's Rho coefficient for each pair of rankings reveals a significance level of correlation of 0.01 with values of 0.646 (DP_2 vs. DEAPC), 0.771 (DP_2 vs. DEAGP) and 0.743 (DEAPC vs. DEAGP) pointing out that there is no differences among the rankings statistically. However, from a sustainability point of view, this affirmation is not real because certainly it is not possible to identify the most sustainable destination due to the dissimilarities in the results.

According to the Spearman's Rho coefficient values, there are small differences between DEAPC and DEAGP. This is because of the use of the same procedure (DEA) in the second stage and the similarity in weights. Five destinations remain in the same position and four achieve the greater variation for those that change their position: five units. The higher dissimilarities are between the DP_2 and the DEAGP. Only one destination remains in the same position: Ciénaga de Zapata; while the higher registered variations for all the comparison are registered for Caguanes N. P, falling seven positions.

This variation is associated with bad performance in six of the twelve indicators considered relevant for the DEAGP index. Furthermore, in five of them, Caguanes N. P. is the lowest or the penultimate among all the destinations: I_{15}, I_{19}, I_{21}, I_{26} and I_{27}. Moreover, differences between these two rankings are caused by the weights distribution, as pointed out before (Fig. 1), for which, the DEAGP has greater values for patrimonial and economic indicators than social, unlike the DP_2, with higher weights for social indicators, then patrimonial and economic.

4.2 Meta-Index Results

Even though there is similarity between the indexes, there are differences among the rankings. It is not possible to establish an overall sustainability ranking. To achieve this goal, it is necessary to create a meta-index starting from the previous classification. As mentioned before, the ideal method to solve this problem is the Borda Count, widely used to combine two or more rankings into one (Nuray and Can 2006; Wu 2011). The order can be found in the last column of Table 3 where Baconao is the most sustainable destination and Guajimico the least.

Baconao has the best sustainability performance because of good scores in the economic and patrimonial indicators, enough to achieve first place with the DEAPC and DEAGP methodologies. Ciénaga de Zapata is the second, helped by good behavior in the patrimonial indicators, which are first and second according to the importance levels for the DEAGP and DP_2. The most influential feature in achieving this target is to be the one with more area devoted to tourism, 4270.6 km^2, five times higher than the second destination in this aspect.

Guajimico remains in the last position, despite the 11th place in the DEAGP obtained by a lower consumption of energy by tourist (I_{26}) and the reduction of the solid waste attributable to tourism.

Despite its location within the best three destinations for the DEAPC and DEAGP indexes, Alejandro de Humboldt N. P. achieved fifth place globally. This result is attributed to eighth position in the DP_2 due to a lower perception of improvement in public services, being one of the destinations with higher water consumption by tourists, and for being one of the highest generators of solid waste because of this activity.

There was a tie in the 12th position between Soroa-Las Terrazas and Topes de Collantes. We used Borda Count over the dimensional indicator to break it and achieve a total order. The final positions were 12th and 13th for Soroa-Las Terrazas and Topes de Collantes respectively. This order responds to a better performance in the social and patrimonial dimensions for Soroa-Las Terrazas in the three indexes.

4.3 Sensitivity Analysis and Robustness

We made a sensitivity analysis with the aim to study the possible variations in the rankings due to some variations in the initial indicators. Using the last, the middle and the first destination, we completed the calculation with a 10 % increase for the sub-indicators of one dimension for Guajimico (15th) and Hanabanilla (8th), maintaining the same values in the two remaining. Similarly, we reduced the indicators of every dimension of Baconao (1st) in the same proportion, keeping constant the other two. The reduction for Baconao was made only as an attempt to study the changes in the rankings, because from a sustainability point of view, the intention is to achieve better values for the worst destinations while maintaining the scores for the best.

Guajimico only varies the position because of an increase in the economic indicators in the DP_2 composite indicator. It improves by one position, from 15th to 14th. This improvement is enough to achieve the 14th position in the overall ranking. For the other indexes and variation of the indicators, this destination remains in the same position. In this sense, a better behavior is going to be found with an improvement in more than one dimension at the same time.

Things are different for Hanabanilla, which only remains constant for an improvement in the patrimonial dimension for the DEAGP. It varies in the remaining eight experiments. The biggest movement was from 9th to 6th place in the DEAPC index, due to a variation in the economic dimension. Despite all the movements registered in the composite indexes, this destination does not change its location in the overall sustainability ranking, maintaining the 8th position.

Despite a drop of 10 %, Baconao maintained the first position in five of the nine combinations: three times in DEAPC and twice in the DEAGP (economic and patrimonial). The higher disparities registered were three positions, from 6th to 9th, in the combination of the DP_2 index and the social and economic dimension. For the meta-index, this destination loses the first position in all the arrangements between the social dimension and the indexes as well as between the economic dimension and the DP_2, in which the higher variation (-2 units) was registered, from 1st to 3rd.

We can assure the existence of a higher robustness of results, mainly for the overall sustainability ranking. 27 combinations were analyzed and 13 movements were registered (48.14 %) in the composite indexes, where the highest variation was 3 places. For the global ranking there were only five movements (18.5 %). In this sense, we must point out that variations could also be associated with the indicators' weights and the methodology used.

5 Conclusions

This paper shows the use of different aggregation methods created to build composite indicators for the achievement of tourist sustainability and, consequently, allows us to establish sustainability rankings.

The new procedures are constructed by the combination of different algorithms such as the DP_2 distance, Principal Component Analysis, Goal Programming and DEA to find different solutions and evaluate the similarity of the results. The approaches differ in terms of the amount of information needed for the calculation process, how they use it to measure the underlying phenomenon, the level of implication with the end user, the choice of the weighting method, and how information is aggregated. They were conceived in such a way as to respond to the stakeholder's necessities in tourist development and with the aim to decrease the weaknesses residing in existent procedures.

Every used method has its own benefits and detriments. The DP_2-Distance indicator was calculated from a smaller set of initial indicators selected as a representative of the sustainability dimensions; it is completely objective for finding weights, and the problem of the information duplicity is solved. The DEAPC indicator has fewer objectives in the way it incorporates the choice made to select the components and how it aggregates the information, but it takes advantage of the overall information contained in all the initial indicators for weighting establishment.

On the other hand, the DEAGP index needs external information to find the weights and is a compensatory approach; however, it offers different ways to calculate the composite measure and represents the desires of the stakeholders related to the initial indicator's values to get a high level of sustainability. Summarizing the last two indexes, the use of DEA in the second stage brings flexibility to the procedure and allows us to identify the contribution of each dimension to the overall sustainability value for the involved destinations.

The methods allow us to establish the sustainability degree of 15 Cuban nature-based tourist destinations from the information contained in 39 indicators, considered as representative of sustainability by means of the Cronbach's alpha coefficient. Those initial indicators correspond to qualitative and quantitative aspects representative of this concept and its three dimensions: social, economic and patrimonial.

Results revealed different sustainability rankings derived from the variances in the applied procedures. The obtained rankings had a great similarity from a statistical point of view with a Spearman's Rho value higher than 0.6 in all cases. Nevertheless, it was necessary to amalgamate all the lists into one to achieve a final level of sustainability using the Borda Count.

We achieved a global ranking of destinations organized from the best to the worst in terms of sustainability by means of a meta-index using the Borda Count approach. It offers the possibility for decision makers to look for alternatives to obtain higher sustainability levels for those destinations with bad behavior, taking into account the better ones as reference points in addition to enabling the stakeholders to approximate the real sustainability ranking with more feasibility and high robustness, contrasted with a sensitivity analysis.

This investigation contributes to the issue of dealing with different rankings and gives different choices to build composite indicators. Nevertheless, no methodology is more suitable than any other for constructing synthetic indicators, as shown by Nardo et al. (2005). In that sense, we cannot conclude that DP_2 is better than DEAPC or DEAGP better than DP_2 or ensure that one of the proposed methodologies is better than other one. It is, in our opinion, a task for future research to determine which method is the best for creating a composite indicator and, for instance, determining the greatest sustainability ranking.

However, although a ranking result is an important factor for benchmarking analysis and reputation management, it is important to be careful about the trustworthiness of a ranking (Wu 2011). This is because ranking results can be affected by calculating mistakes, human bias, and the use of a specific ranking method.

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